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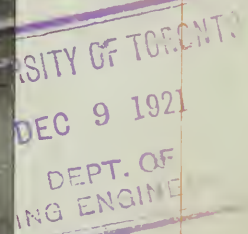
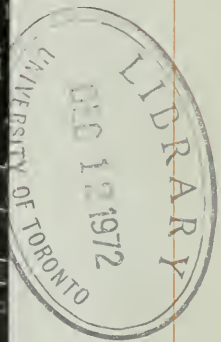
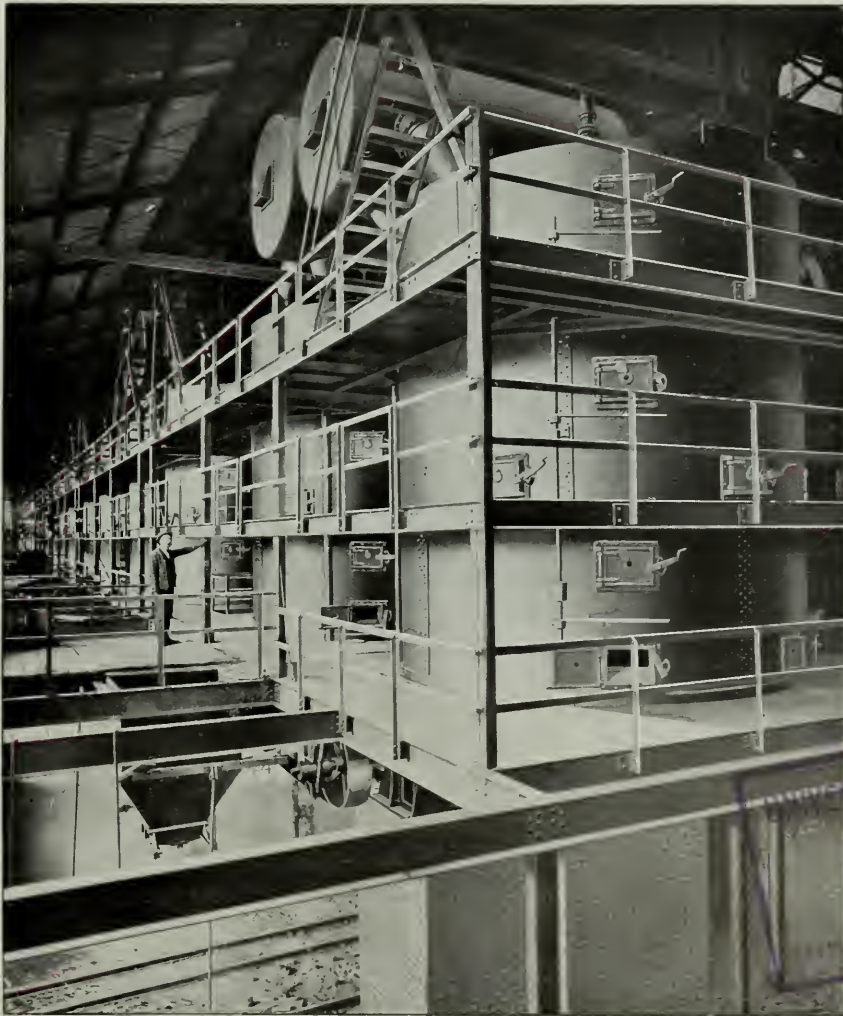
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STORAGE
Allis-Chalmers
Manufacturing Company
Mining Machinery Department

Bulletin No. 1804

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September, 1915

McDougall Roasting Furnaces



Anaconda Copper Mining Co.'s Roasting Plant—The Largest in the World—
Where 56 McDougall Furnaces are Installed.

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MILWAUKEE, WIS., U. S. A.

By Allis Chalmers Manufacturing Company

The McDOUGALL ROASTING FURNACE is a mechanically operated, circular, multiple-hearth furnace of the self-contained type, (having two or more hearths superimposed upon each other) and contains the largest amount of hearth area, in proportion to floor space occupied, of any roasting furnace on the market.

The furnace consists of a cylindrical shell made of steel plate which contains and supports the various hearths, shafts, rakes, feeder, etc. This shell, together with the cast iron plates, which form the bottom of the furnace, are, in the standard type of furnace, supported some ten or twelve feet above the ground level by structural steel beams and columns; the latter also carry the driving machinery.

The shell of this furnace, when used on self-roasting ores, has a brick lining 9 inches thick, from which are sprung, at intervals of about 3 feet, flat arches that form the various hearths of the furnace. These arches are also 9 inches in thickness; the entire brickwork for one of the furnaces being built from common red brick. In the case of ores carrying a large percentage of combustible matter, it is advantageous to use a single course of fire brick around the openings where the calcine is discharged from one hearth to the next, as the combustion is considerably more vigorous at these points.

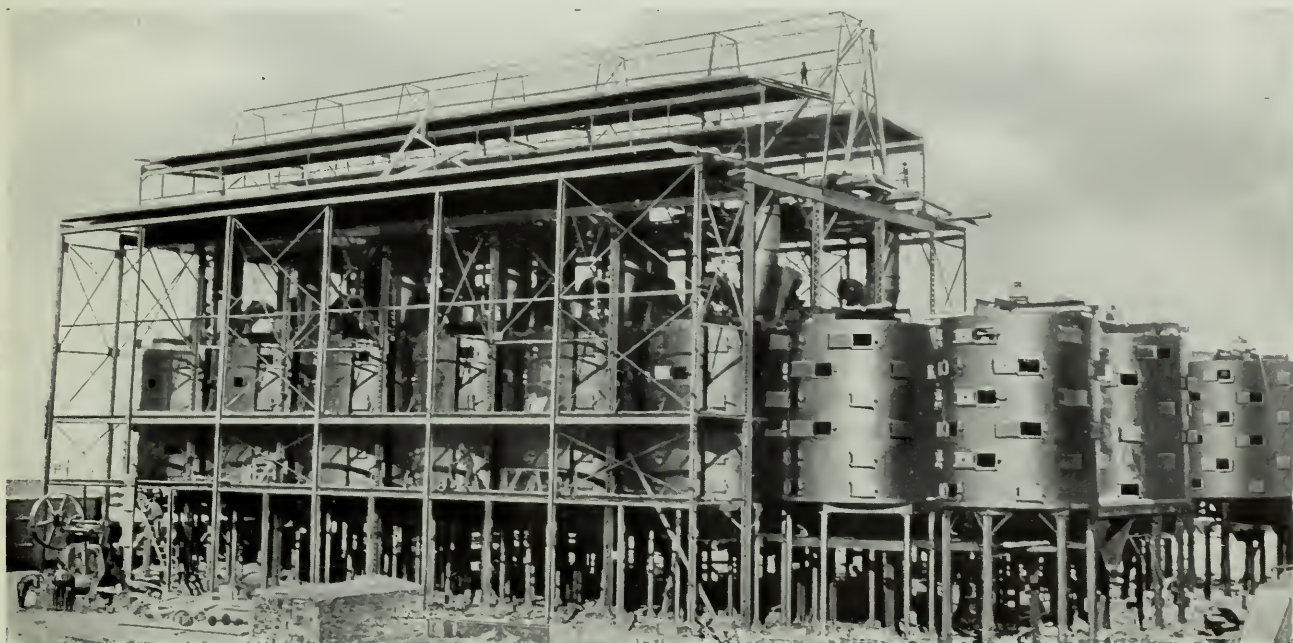
The ores are fed by an automatic arrangement through the roof, or top arch of the furnace, in such a manner as to seal this opening against the entrance of cold air or the egress of gases. The mechanical arrangement for stirring the ores during their calcining, and for conveying them from one hearth to the other, consists of a vertical, hollow, cast iron shaft extending through the several hearths of the furnace, having two or more radial cast iron arms attached to it, for each hearth. Suspended from the under side of these arms, are cast iron plows or rakes, which are set at an angle to their direction of rotation, so that their effect is not only to continuously stir the material being calcined, but also to convey it toward the center or the periphery of the various hearths, where there are openings provided so that the calcines are discharged at these points to the hearth below.

Attached to the under side of the furnace is a steel calcine hopper, which is made of proper capacity and shape to suit the individual installations. This hopper is provided with a sliding gate for removing the calcines, which prevents the discharge openings from admitting an excess of cold air; the admission of air being more advantageously regulated by the side doors, of which there are usually twenty-eight in a six-hearth furnace.

The central shaft and arms are provided with either our well known patented water cooling or air cooling device, as preferred, which prevents any injury from over-heating. The air-cooled shafts and arms are preferable if the water supply available is limited, or very bad.

With either type of cooling arrangement, it is possible to attain a high degree of heat without injury to the stirring mechanism. The shaft and arms are usually run at a speed of, from three-fourths to one revolution per minute, although this may be varied to suit the characteristics of the particular ore or material being roasted and the amount being fed in, as this amount is variable between wide limits, by the action of our automatic feeder.

For convenient operation, a six-hearth furnace requires two working floors, the one placed on the level of the bottom hearth, and the second about nine feet above it. This allows of ready access to the doors on any of the hearths.



International Smelting & Refining Co.'s Roasting Plant—Thirty-two McDougall Furnaces

The driving machinery, as usually installed, is belted from a countershaft attached, either to the furnace columns or to the side of the building. A friction clutch is furnished which may be located upon this countershaft or upon the driving shaft of the furnace immediately underneath it; the operating lever of this clutch is connected to a vertical shaft which extends through both working floors of the furnace, enabling the operator to stop and start the stirring mechanism from either of these positions. The small amount of power requisite to operate the automatic feeder is taken from the top of the central shaft, which extends through the top hearth, for attachment of gearing and to admit of the connection of the cooling arrangement.

The illustrations (Figures 1 and 2) show installations of McDougall furnaces. Figure 1 is typical of practice where the contour of the ground will permit of ore cars being run directly over the top of the furnace for unloading into the feed hoppers.

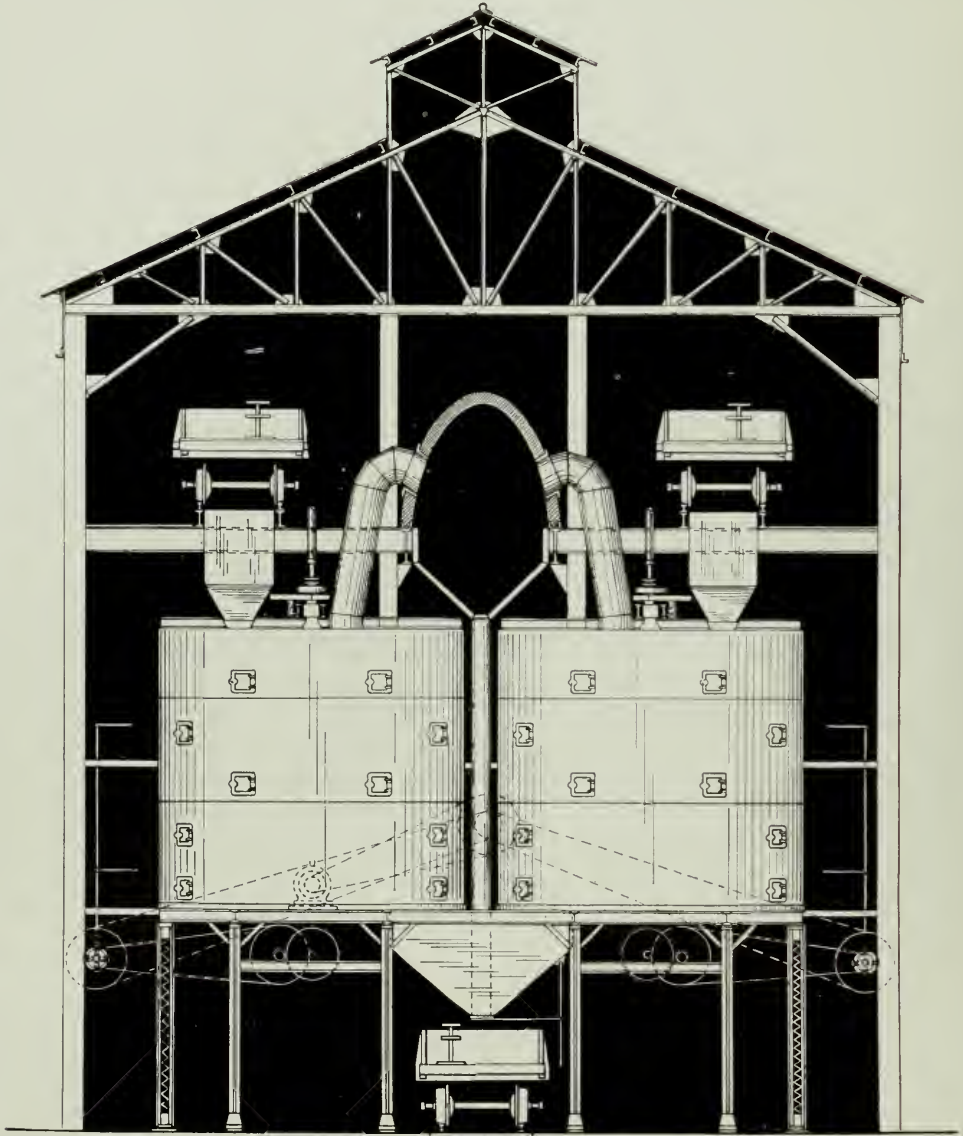
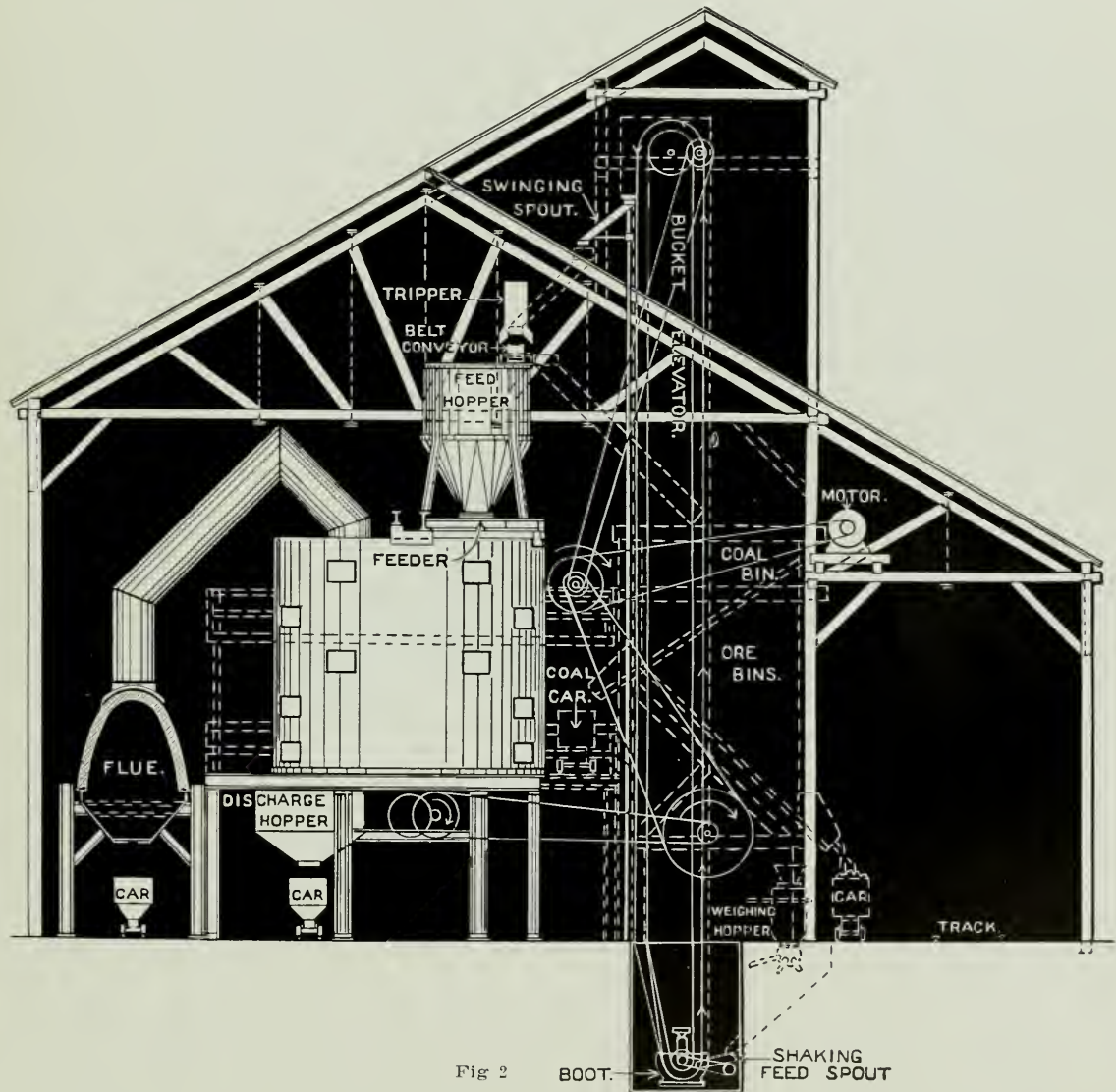


Fig. 1

Figure 2 shows a plant, the plan of which is often followed where it is impractical or inadvisable to extend tracks directly over the furnace. In this plant it would have required an expensive trestle to permit of the ore cars being hauled directly to the charge-floor as the ground was uniformly level. For this reason, a bucket elevator, together with a belt conveyor extending the full length of the building, was adopted.

The title page illustration is a view in the roasting building of the Anaconda Copper Mining Company, where they have installed fifty-six (56) McDougall furnaces, this being the largest calcining plant in existence.



We build numerous modifications of this furnace, adapting it to ores having very different characteristics. In the case of material containing a large amount of fines, which would be liable to loss by being carried off by strong draft during the falling from one hearth to the other, we introduce a series of inclined planes, down which the material slides without disturbance, thus preventing any undue loss. For uniformly coarse material, the vigorous combustion occasioned by the precipitation from one hearth to

the other is a decided advantage, so that we do not furnish the modification referred to unless the condition of the ore requires it.

When it is necessary to recover the sulphurous acid for acid making, we furnish these furnaces with one or more muffled hearths; we also build them for this purpose, by diverting the coal gases from the lower hearths, the percentage of sulphur in the ore being sufficient to maintain a vigorous combustion in the upper hearths, the ore passing through a normally sealed opening into this lower hearth. This is a much more efficient furnace than the muffled type, but necessitates the wasting of the small amount of sulphur dioxide set free in the lower hearth.

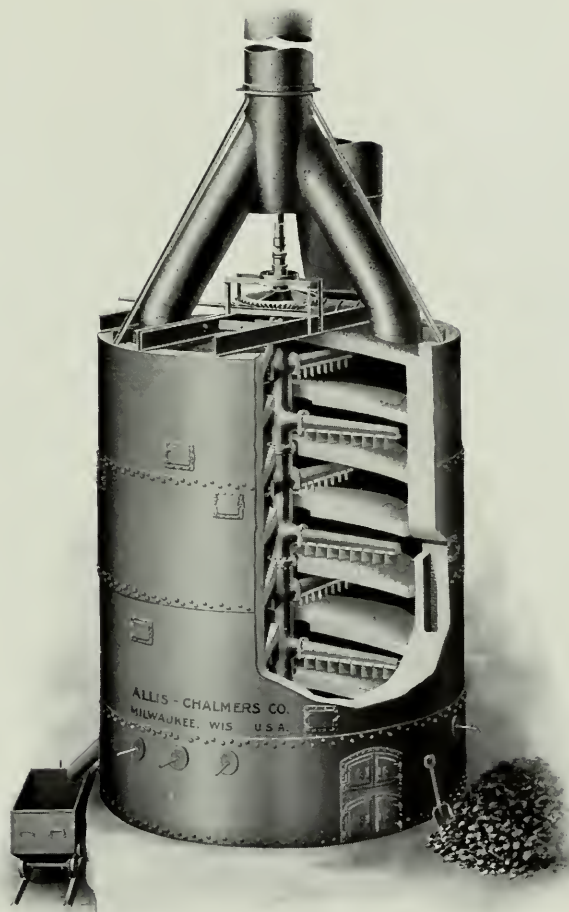
These furnaces are used in Montana and Utah on sulphide ores carrying approximately 35% of sulphur, the calcines discharged from the furnace containing from 7% to 9%. Where it is desirable to reduce this residual sulphur to a lower percentage, we supply fire boxes which are erected underneath the furnace or on the first working floor, as desired, or they may be incorporated in the body of the furnace, being located underneath the lower hearth. It is possible to give almost any desired amount of grate area to a furnace, so that, if necessary, material can be brought to a dead roast and subjected to temperatures up to 2000 degrees Fahrenheit, or more.

INCLOSED FIRE BOX TYPE.

This furnace is designed for roasting heavy sulphide ores, those that may carry little combustible matter or, in fact, any ore or material where the roasting process must be carried on by the addition of external heat.

The furnace is designed for large capacities, discharging 30 to 50 tons of "sweet" roasted product in 24 hours, depending upon the amount and the molecular arrangement of the substances to be eliminated. The furnace consists of five or six superimposed hearths, (the number and size of hearths can be changed to suit conditions). The cut, which follows, shows a six-hearth furnace having a rotating central shaft carrying rabble arms and rakes. The general construction is similar to the standard Klepetko-McDougall furnace, having all of the valuable features of the latter, with many modern improvements.

The main difference between the "inclosed fire box type" and the "standard" furnaces is that, under the 6th hearth, counting from the top, there are two fire grates which have one general combustion chamber. This chamber extends under the entire 6th hearth; the hot gases arising from the combustion of the fuel, (either coal, wood or oil) are carried out and up through separate flues that lead to the 6th, 4th and 2d hearths, so that each of the hearths is supplied with three hot gas flues which are arranged at 120 degrees from each other. The capacity of the flues that lead to any one hearth is sufficient to carry the total gases arising from the combustion of the fuel so that, by the aid of dampers, any portion of the heat can be applied to any one of the



McDougall Roasting Furnace—Inclosed Fire Box Type

three hearths. As an illustration, we could apply 75% of the heat to No. 6 hearth, 15% to No. 4 and 10% to No. 2, or, vice versa; Or we could apply all of the heat to any one hearth, depending upon the actual requirements.

This regulation of heat is especially valuable in the treatment of ore containing a mixture of non-magnetic sulphides and zinc sulphide, where it is necessary to break up this compound for subsequent magnetic separation from the zinc, among the requisites in this roasting being a very close regulation of heat and of the amount of air admitted.

The firing of the coal is done in the same way as with a boiler. The doors and ash pit are similar. The grates are of the ordinary stationary boiler type. Shaking grates can be substituted, if desired. The ore is fed into the furnace from the automatic feeding device, the same as used in the "standard" McDougall furnace. The feed hopper can be charged from overhead tracks and cars or with an elevator. These hoppers are made any required size, so as to hold from 5 to 20 tons. The roasted ore is discharged from a spout at the side into calcine cars or, if it is to be treated by the cyanide process,

this spout can discharge to a cooling conveyor that carries the material to the tanks or bins.

The driving machinery is mounted on the top of the furnace, thus being readily accessible for oiling and adjusting. The step bearing at the bottom of the shaft is reached by a manhole and, as the shaft itself is water or air cooled, there is no danger of the bearing becoming hot.

This furnace is adapted for a large class of ores that have heretofore only been treated in the "straight-line" furnaces. There are many advantages embodied in this furnace that are not in the "straight-line" type. Its compactness, accessibility, ease of operation, the control of the roasting through the various hearths and the small amount of heat lost by radiation, are features which enable ore to be roasted at a minimum cost of fuel and other operating expenses.

The capacity of these furnaces varies, of course, with the character of the material calcined, its degree of fineness, amount of moisture, etc. A careful test made in Montana on a battery of four "standard" McDougall furnaces on a continuous run of 10 days, gave an average of 36 tons per day (of 24 hours) of copper sulphide concentrates roasted per furnace. This was on the older type of furnace having an outside diameter of about 16 feet and containing only 870 square feet of hearth area. The later furnaces are 18 feet in diameter and contain about 1200 square feet of hearth, which very materially increases their capacity. We also build larger sizes.

The repairs to these furnaces are very small, the parts replaced being practically limited to the plows or rakes. On copper concentrates, the average wear on the plows amounts to only $\frac{1}{4}$ to $\frac{1}{2}$ pound of cast iron per ton of material treated.

The power required for operating a single McDougall furnace will average from $2\frac{1}{2}$ to 4 horse power, the larger amount being necessary in case it is deemed advisable to plow up the compacted concentrates which accumulate near the periphery of the heart. On an installation of 16 McDougalls driven by a single motor, it was found that each furnace required on an average of $1\frac{2}{3}$ horse power, the losses in belting and countershafting between the motor and furnaces being distributed among the entire number.

In shipping McDougall furnaces, the steel plates forming the shell are punched, rolled and nested, being shipped in this knocked down form to lessen freight charges. The cast iron parts, consisting of central shaft, arms, bottom plates, etc., are sectionalized to a sufficient extent to permit of convenient handling and erection.

We are prepared to furnish complete outfits, comprising, besides the furnace proper with its supports and hoppers, all necessary flues, stack, countershafting, belts, motors, working floors, elevators, conveyors and any other accessories which the design of each individual installation may require. A six-hearth furnace having an outside diameter

of 16 feet will require in its erection about 23,000 brick, and has a total weight when erected of about 150 tons.

The following installations of McDougall furnaces are in operation or under erection:

Anaconda Copper Mining Co., Anaconda, Mont.	56	Furnaces
American Smelting & Refining Co., Garfield, Utah	22	"
Boston & Montana Smelter, Great Falls, Mont.	20	"
Highland Boy Smelter, Murray, Utah	20	"
Nevada Consolidated Copper Co., Ely, Nevada	16	"
Cerro De Pasco M. Co., Peru	14	"
International S. & R. Co., Tooele, Utah	10	"
Yampa Smelting Co., Bingham, Utah	9	"
Ozark Zinc Oxide Co., Coffeyville, Kansas	4	"
Balaklala Cons. Copper Co., Coram, Calif.	4	"
Cananea Cons. Copper Co., Cananea Sonora, Mex.	10	"
Boston & Colorado Smelting Co., Argo, Colo.	3	"
Copper Queen Cons. M. Co., Douglas, Ariz.	6	"
North American Lead Co., Fredericktown, Mo.	2	"
Butte Reduction Works, Butte, Mont.	2	"
Vanadium Alloys Co., Newmire, Colo.	1	"
Arizona-Mexican Mining & Smelting Co., Needles, Calif.	1	"
American Sheet & Tin Plate Co., Vandergrift, Pa.	1	"
Canada Zinc Co., Nelson, B. C.	1	"
Monte Cristo Metals Co., Monte Cristo, Wash.	1	"
The British Metals Extraction Co., Ltd., England	1	"
Mine La Motte Smelting Co., Mine La Motte, Mo.	1	"
Caucasus Copper Co., Batoum, Russia	2	"
C. Pass & Sons, Ltd., Bristol, England	1	"
Britannia M. & S. Co., Britannia Beach, B. C.	1	"
United States S. R. & M. Co., Needles, Calif.	1	"
Union Miniere du Haut Kantanga, Africa	2	"
Compania Minera de Oruro, Oruro, Bolivia	1	"
American Smelting & Refining Co., Hayden, Arizona	8	"
Thos. Bolton & Sons, Ltd., Widnes, England	1	"
Pahaquarry Copper Co., Bangor, Pa.	1	"
The Famatina Co., Ltd., Rosario, Argentine Republic	2	"
Total	225	"

Allis-Chalmers Manufacturing Company

General Offices, Milwaukee, Wis.

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Cleveland, O., Schofield Bldg.	Philadelphia, Pa., 903 Pennsylvania Bldg.
Dallas, Texas, Sumpter Bldg.	Pittsburgh, Pa., 1209 Park Bldg.
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Detroit, Mich., Ford Bldg.	St. Louis, Mo., Railway Exchange Bldg.
Duluth, Minn., Alworth Bldg.	Salt Lake City, Utah, Kearns Bldg.
Indianapolis, Ind., 516 Traction Terminal Bldg.	San Francisco, Cal., Rialto Bldg.
Kansas City, Mo., Waldheim Bldg.	Seattle, Wash., 115 Jackson St.
	Toledo, O., Ohio Bldg.

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Santiago, Chile, Huerfanos, 1157, Casilla 2653.

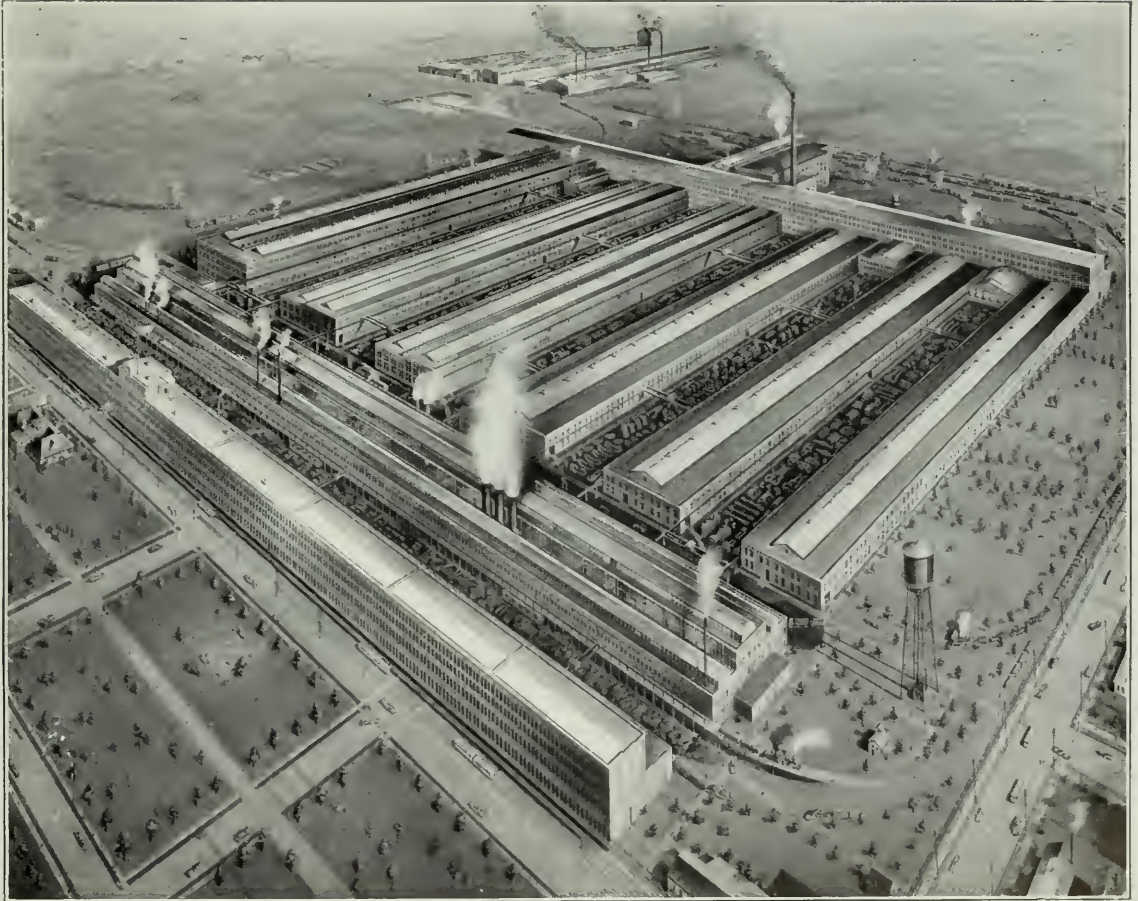
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Canadian Allis-Chalmers, Limited, Toronto, Ont.

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Auckland, New Zealand,	Jno. Chambers & Sons, Ltd.
Bombay, India,	Marshall Sons & Co.
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Rio de Janeiro, Brazil,	American Trading Co.
Petrograd, Russia,	International Engineering & Trading Co.
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Singapore, Straits Settlements,	McAlister & Co., Ltd.
Sydney, Australia,	Frank R. Perrot
Sydney, Australia,	Standard-Waygood, Ltd.
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McDOUGALL ROASTING FURNACES



West Allis Works of Allis-Chalmers Manufacturing Company Where Complete Equipment for Mining, Milling and Smelting are Manufactured

Allis-Chalmers Manufacturing Company's

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Rotary Soil Tillers

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Tube Mill Linings
Tube Mill Pebbles

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Revolving Screens
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CONDENSERS

Barometric
Jet
Surface

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Jaw Crushers
Macadam Plants
Perforated Metals
Portable Crushing Plants
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Flaking Machines
Flour Feeders and Mixers
Flour Packers
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Reels
Rolls
Roller Mills
Rolling Screens
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Electric Driven
Steam Driven

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Oil Pressure Governors

MANGANESE BRONZE CASTINGS MINING MACHINERY

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Chilian Mills
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Cyanide Plants
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Frue Vanners
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Band Re-saws, Horizontal
Band Re-saws, Vertical
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Cant Flippers, Steam
Canting Machine, Overhead
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Conveying Machinery
Cutting Off Saws, Steam Feed
Edgers
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Feeds, Steam, Direct Acting
Feeds, Steam, Twin Engine
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Log Chains
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Log Turners
Niggers, Steam
Set Works
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Transfers
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Engine Type Generators
Fly-wheel Type Generators
Turbo Generators

Water-wheel Type Generators
Synchronous Frequency Chargers
Induction Motor Frequency Chargers

Synchronous Motor-Generator Sets
Induction Motor-Generator Sets
Synchronous Motors
Synchronous Condensers

Induction Motors
Transformers
Rotary Converters

Direct Current Generators and Motors

Belted Type Generators
Engine Type Generators

Small Bipolar and Multipolar Motors and Generators
Electric Railway Equipments, Motors, Controllers, etc.

Multiple Voltage Balancing Sets
Multiple Voltage Variable Speed Equipments

Switchboards for Direct Current and Alternating Current